

AN ANALYSIS OF THE IMPACT OF FEDERAL EXPENDITURES
ON SELECTED SUB-STATE REGIONS

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MIDWEST RESEARCH INSTITUTE

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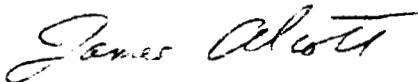
PREFACE

The economic impact of Federal programs is of primary concern to those responsible for administering the programs as well as to those in the affected regions. Although some work has been done recently on estimating the economic impact of Federal expenditures on the states, little has been done at the sub-state level. This report,* the final in a series of reports dealing with a six-state midwestern region, describes and tests a procedure for determining the impact of Federal expenditures on the economies of sub-state regions.

The study was conducted by Dr. Darwin W. Daicoff with the assistance of Mr. Vincent M. Gillespie, Mr. David Loy, Mr. Jerry Metz and Mr. Jack Weeks, all of the University of Kansas. The study was under the general supervision of Mr. Bruce W. Macy, Principal Economist, and Mr. Michael Van Meter of the Midwest Research Institute staff.

Approved for:

MIDWEST RESEARCH INSTITUTE



James Alcott, Director
Economic Development Division

27 July 1966

* Midwest Research Institute, Techniques for Estimating County Income in a Six-State Area, 1 June 1966.

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W. Nelson Peach, Richard W. Poole, James D. Tarver, Larkin B. Warner and Lee B. Zink, Source Notes and Explanations for County Building Block Data for Regional Analysis, Research Foundation, Oklahoma State University, March 1965.

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SUMMARY

The basic objective of this study is to develop procedures for determining the impact of the aero-space program on the economy of sub-state regions. The annual estimates of county income for a six-state midwestern region, developed previously as part of this research program, provide the essential ingredients for an effective regional impact analysis.

The first step in the study is to develop a general impact model that can be implemented at the regional level. It is found that, by beginning with a rather elaborate model of a regional economy, it is possible to translate this model into a formulation that can be tested using available data.

As a second step, the data generated in the six-state county income study are utilized to test this impact model. In essence, the model rests upon the ability to differentiate income into two components -- exogenous and endogenous income. Exogenous income is income that, although received in the region under consideration, is subject to forces outside the region. Endogenous income refers to income earned within the area that is subject only to local economic forces.

Total personal income for eleven Standard Metropolitan Statistical Areas for the period from 1950 to 1962 was broken down into these two income categories, and statistical methods which apply the county income data to the modified model were tested. It was found that rather consistent estimates of the impact of changes in the level of exogenous income on the level of total income may be derived for nine of these SMSA's.

Finally, the model is applied in the analysis of the impact of defense spending on regional growth in this six-state region.^{1/} Data were developed that measure the three components of defense spending -- defense

^{1/} Defense Department expenditures were used because sufficient data on NASA expenditures on a county basis were not available. Recent efforts have been made to generate additional data relating to NASA contracts and subcontracts, but the historical period covered by these data was not sufficient to allow their use in this study.

procurement, military wages and salaries, and Department of Defense civilian wages and salaries. And it was found that, even with rather sketchy data, it is possible to develop a series of estimates of the amount of defense spending in each of these metropolitan areas. An analysis was then made of the impact of changes in the level of defense spending from 1960 to 1962 on each of the SMSA's.

It was found that the relative contribution of defense spending to the growth of income in these nine areas differed widely. In two of the areas Wichita and Topeka, Kansas, negative changes in defense spending acted as a depressant on the rate of growth of income in these areas. On the other hand, in Cedar Rapids, Iowa, and Little Rock, Arkansas, defense spending increases provided a large stimulus to the rate of growth of income. Thus, although the 1960-1962 period may be somewhat limited, it is possible to differentiate between the contribution of defense spending to area growth for these nine metropolitan areas of the Midwest.

I. INTRODUCTION

"Impact" has always been a major concern of Federal administrators. In recent years a growing number of programs, such as the economic development programs, have been designed specifically to create a positive economic impact. For many agencies, such as the National Aeronautics and Space Administration, the Department of Defense, and the Atomic Energy Commission, economic impact, although not central to the primary mission, has been of major concern. Thus, as the data and analytical tools have improved, measurement of economic impact of Federal programs has become a primary preoccupation of economists.

Since Keynes, economists have used general impact models -- theoretical formulations which analyze the conditions and results of changes among many economic magnitudes. Although older classical economics generally ignored impact model formulation, the primary concern of modern economics has been to determine the impact of changes on certain economic variables. This has resulted in the development of macroeconomic impact models that explain or predict the size of broad classes of economic variables, e.g., output or income. These economic models employ economic theory, mathematical analysis, and statistical methodology to analyze economic data. Certainly economic analysis can be presented without reference to empirical data; however, when such data are available, they enhance the analysis by making it more meaningful. Moreover, they allow the economist to test of the adequacy of his theoretical assumptions.

Much, if not most, of our present knowledge of the functioning of the United States economy and almost all of our analytical forecasting of economic events rely heavily on the output and income data for the United States. The impact of so wide a range of policy variables as tax rates, public expenditure programs, and the money supply has been analyzed at the national level through the use of these output and income data.

Although the economic data available at the national or state level are not complete, they are much more adequate than are those for the sub-state level. This data problem tends to restrict the type of analysis that can be carried out at the regional or county level. Yet the economic impact of the aero-space program is often concentrated at specific areas within certain states. Therefore, improved economic data for sub-state areas are an essential ingredient for effective regional impact analysis of the aerospace program. The annual estimates of county income for a six-state midwestern region, developed previously as a part of this research project, provide this basic regional data.^{1/}

^{1/} Midwest Research Institute, Techniques for Estimating County Income in a Six-State Area, 1 June 1966.

The approach followed in this study draws heavily on the work done by Roger Bolton in his analysis of the impact of defense expenditures on the states.^{2/} The effort here was to apply these techniques, with certain modifications, to sub-state areas.

The analysis presented in this report is neither conclusive nor exhaustive; however, it illustrates the type of study that such data will permit. Further, this study includes specific cases, those dealing with public policy impact in the six-state area, which exemplify the use to which these data may be put.

^{2/} Bolton, Roger E., Defense Purchases and Regional Growth, The Brookings Institution, Washington, D. C., 1966.

II. A GENERAL IMPACT MODEL

This section develops a general economic impact model that can be used for regional analysis. The model is so formulated that it will, for a given region, determine the consequence of defined economic changes on the economic activity of that region.

Conceptual Framework

The Introduction proposed that a general impact model should be formulated in macroeconomic terms. As a consequence, then, the economic magnitudes employed in the model are broad aggregates. One of the consequent limitations of the model is that important variations within these aggregates may be obscured. For example, although income may be increasing it is entirely possible that one or more components of this income may be declining; this variation is not observable through the macroeconomic measure of income. Although this is a conceptual problem, it is no more so at the regional level than it is at the state or national level. Further, since the use of these broad aggregates has proven to be satisfactory for national and state analysis, there is no reason to expect them to be less adequate at the regional level.

Since this model must reflect regional economic changes resulting from the influence of extra-regional forces (in this case defense expenditures), a first step must be to decide which economic measure best reflects these changes. Obviously not all economic indicators can serve the purpose since the study focuses upon determining the impact of these external forces on the economic well-being of individuals residing in the region. Thus, although a model could indicate the changing levels of employment due to external forces, and yet another could reflect (in terms of taxes and government spending) the ability of local governmental units to finance public expenditures, the present model, because it is concerned with individual economic well-being, is formulated in terms of personal income changes within a specified geographic region.

Although economic well-being is too comprehensive a concept to be reduced to a single measure, personal income is recognized as a universal measure of this concept. Thus, personal income, especially per capita personal income, is used as the basic economic measure. In effect, then, the impact model in this study rests upon the assumption that an adequate determination of impact of extra-regional forces upon the specified geographic area may be derived by ascertaining the measurable changes in personal income resulting from these forces.

One may question why income rather than output was chosen as the measure of economic welfare. One reason is that the demonstrable relationship existing between production and income argues for the use of the more convenient measure -- income. More importantly, however, is that production is less comprehensive a measure of well-being than is income. While local production provides an index of economic activity, measurable by local employment levels or by the extent of capital utilization, activity is not equivalent to welfare. A region's population may gain income from production that occurs outside the region and, thus, receive income in excess of the region's production. This inter-regional income is important in measuring the well-being of individuals and is not discernible through production, employment or capacity utilization measures.

Ideally, only income available for personal use should be included in a measure of economic well-being and adjustments to total income are often made to account for such deductions as personal taxes. Whatever remains after such deductions is referred to as disposable personal income. Doubtless, disposable personal income is a valid indicator of economic well-being; however, less detailed data for this measure exist than for personal income. Thus, greater reliability justifies the use of personal income at this time. Subsequent studies, when sufficient data on disposable personal income are available, would be a valuable addition to this study.

Another frequent adjustment is to express personal income in real terms rather than in dollar terms. Real terms, it is often argued, eliminate distortions resulting from price level differences among various geographic regions. Whether this modification must be made depends on the degree of price variation. The regional price data that are available show only slight variations in price level movements among various regions of the U. S. To the extent that these data are accurate, one can be confident that serious misrepresentations are not made by not adjusting personal income to account for price movements. This is fortunate, for regional price data are rather sketchy and it would be very difficult to obtain a full set of price data for the region examined in this study.

Finally, one distinctive characteristic of the model developed in this study should be noted. This is, that the model is a partial and not a general equilibrium model. In other words, the model measures the impact of extra-regional economic events as they affect each region separately. A general equilibrium model, which would measure all effects which all regions would have on one another simultaneously, has not been developed by economists much beyond a theoretical framework. However, our objective is to quantify the impact; hence, a full, general equilibrium model cannot be employed. On the other hand, because a purely partial equilibrium model inflexibly holds constant all elements of the economy other than the element under consideration, the model developed here is modified. This modification allows the construction of a more sophisticated model for it projects the reciprocal effects of some of these interacting forces.

A General Model

A general impact model may be developed using Keynesian, macro-economic, analysis. Here the output, income and expenditure for any given area consist of that area's consumption goods, investment goods, and government services. That is, the goods and services produced in the area are considered its output; the income generated by this production is the area's income; and the area's expenditures are the sum of its consumption spending, investment spending and government spending. It is common to distinguish between local and foreign investment activity. Further, it is usual to derive an area's net investment by deducting that capital which it consumes in the production process.

A region's income, then, consists of either the sum of its production or the sum of its expenditures for domestically produced goods plus those expenditures for exported goods in excess of the area's total imports. Usually these goods are separately expressed as consumption, investment and government. Thus, the following definitional equation may be stated as:

$$Y_d = C_d + I_d + G_d + C_x + I_x + G_x - C_m - I_m - G_m \quad (1)$$

where C = consumption, I = investment, G = government, d = goods or services produced and consumed in the area, x = exports, and m = imports.

To construct a general impact model, one must first determine the amount of each of these nine components of income. Although multiple factors determine the value of each, only one will be used here -- the level of income. The total of area consumption, investment, and government goods plus the imports of consumption, investment and government goods depend on the level of area income (Y_d). Exports, whether of consumption, investment or government goods, depend, in turn, on the level of foreign income (Y_f). Expressing this dependence in a linear form we have:

$$C_d = a + bY_d \quad (2)$$

$$I_d = c + dY_d \quad (3)$$

$$G_d = e + fY_d \quad (4)$$

$$C_m = g + hY_d \quad (5)$$

$$I_m = i + jY_d \quad (6)$$

$$G_m = k + \ell Y_d \quad (7)$$

$$C_x = m + nY_f \quad (8)$$

$$I_x = o + pY_f, \text{ and} \quad (9)$$

$$G_x = q + rY_f \quad (10)$$

Substituting equations (2) through (10) in equation (1) and solving for Y_d , the following equation may be produced:

$$Y_d = \frac{1}{1-b-d-f+h+j+\ell} [a + c + e - g - i - k + m + o + q + (n + p + r) Y_f] \quad (11)$$

This equation measures the area income as it depends on the relationship between income and its use internally and the influence of the level of income outside the area. The equation combines a multiplier, a reciprocal term, and a multiplicand (the terms within the brackets). The multiplier may be looked on as the reciprocal of the leakages from the area spending stream. These leakages result from the specific relationship between an area's spending and its income. The larger the marginal propensity to spend in the area, the larger will be b , d or f , and the larger will be the multiplier. On the other hand, the larger the marginal propensity to import, the larger will be h , j or ℓ , and, consequently, the smaller will be the multiplier.

The multiplicand is composed of four related formulations:

the first -- $(a + c + e)$ -- indicates that area spending which is unrelated to the area's income (for example, the amount of individual spending on area-produced consumption goods that would occur even if the individual had no income),

the second -- $(-g - i - k)$ -- indicates the area imports which are not dependent on area income (the amount of individual spending on imported consumption goods that would occur even if the individual had no income),

the third -- $(+m + o + q)$ -- indicates the area exports which are not dependent on foreign income (the amount of spending by foreign individuals on area produced consumption goods that would occur even if the foreigner had no income), and

the fourth -- $+(n + p + r) Y_f$ -- indicates the marginal propensity of the foreign area to spend in the local area times the level of foreign income (the amount of area exports of consumption goods that is dependent on foreign income).

Equation (11) is a general formulation that algebraically expresses an economic impact model in terms of area income and foreign income. With this model any number of areas can be considered by using equations (2) to (10) to express each area's relationship to every other area. A model could be developed in which each area could be treated separately and, then, combined for all areas. If this were done, a set of equations similar to equation (11) would be developed for each area.

A Modified Model

Unfortunately, the data necessary to estimate equations (2) through (10) are unavailable. As a consequence, a grouping of these nine relationships must be considered. It is useful to think of two classes of income: (1) exogenous income, that which depends on forces outside the area, and (2) endogenous income, that which depends on forces inside the area. If, then, the income defined in equation (1) is so classified, C_d , I_d , G_d , C_m , I_m , and G_m indicate endogenous income and C_x , I_x , and G_x indicate exogenous income. Thus, the area's total income is its combined exogenous and endogenous incomes. Algebraically the model is expressed as:

$$E = C_d + I_d + G_d - C_m - I_m - G_m \quad (12)$$

plus

$$X = C_x + I_x + G_x \quad (13)$$

equals Y_d , and

$$Y_d = E + X. \quad (14)$$

Again, if the relationship between X and area total income can be assumed to be linear, then,

$$E = s + tY_d \quad (15)$$

and

$$X = \bar{X}, \quad (16)$$

that is, X is assumed to be known. Hence, it follows that,

$$Y_d = \frac{1}{1-t} (s + X). \quad (17)$$

This equation may be interpreted the same way as equation (11). The level of area income is equal to the product of a multiplier and a multiplicand. In this case, the multiplier is a much simpler one -- $\frac{1}{1-t}$ -- that is, one over one minus the marginal propensity to spend in the area. The multiplicand is the level of spending that is independent of the level of area income. It consists of that area spending which is unrelated to the area's income and all foreign spending done in the area. This model is similar to that used by Bolton.^{2/}

In addition to an expression for total income, such as equation (17), an alternative formulation of the relationship may be developed to produce an expression of endogenous income. This is:

$$E = \frac{1}{1-t} (s + tX).$$

^{2/} Ibid.

III. A TEST OF THE IMPACT MODEL

This section is devoted to the empirical testing of the previously described impact model. Endogenous and exogenous income are defined, and both the geographic area and the time period considered in the model are described. The section also outlines the statistical modifications of the model. Finally, the statistical results are presented.

Exogenous and Endogenous Income Defined

The present impact model describes the relationship between total personal income and exogenous income and indicates that any change in the latter induces variations in regional endogenous income.

Obviously, the statistical and theoretical results of such a study will depend, in part, on the manner by which the terms and concepts of the model are described. It is necessary, then to describe the study's terms and to indicate how they differ from other similar concepts.

This study follows Bolton's terminology to designate the components of personal income. Exogenous income is defined as that income which comes from outside a region, and more particularly, as that income derived by a region's selling goods and services (including capital services) to other regions.

Although some studies have employed Douglas C. North's term "export base"^{3/} to denote that bundle of commodities and services which a region exports, the concept compared to that employed by Bolton is too restricted for a measure of total personal income. Bolton's "exogenous income" includes not only North's "bundle" of export goods and services, but more accurately reflects total "outside" income by including, also, unearned income derived from government farm programs, transfer payments, and all other income entering a region. In theory then exogenous income, as defined by Bolton and used in this study, includes North's "export bundle," unearned income from external areas, and income earned elsewhere by region residents.

^{3/} North, Douglas C., "Location Theory and Regional Economic Growth," Journal of Political Economy: June 1955, and reprinted in Friedman, John and Alonzo, William (eds.) Regional Development and Planning, M. I. T. Press, Cambridge, 1964, p. 244.

Endogenous income as used here is, similarly, based upon Bolton's use of the term. P. Sargent Florence's term "residential industry"^{4/} as used by North, is quite similar to what is here called endogenous income, but like his use of "export base," his concept is less satisfactory for this study's aims. Income arising from "residential industry" refers to that income resulting from industry serving its region's market, "endogenous income" refers to the residual component of personal income after exogenous income has been subtracted from total personal income. Other terms used to denote these two classes of income are: basic and non-basic, city-founding and city-filling, primary and secondary basic and service, foundation and residential, and finally city-forming and city-serving.

Personal Income as a Dependent Variable

Since the model is designed to explain the historical economic development or to predict the course of the future growth of a region by describing a specific measure of income as reflected in limited independent variables, the definition of those variables is crucial. A regionally based study must define its classes of activity or types of income in a manner most suitable to the objectives of the study and to those data used. Regardless of the definitions chosen, they should be consistent throughout the study; too, the conclusions reached by the study should be explicitly framed in terms of its definitions.

The dependent variable used in the model is that of total personal income within various Standard Metropolitan Statistical Areas. The components of this personal income are those compiled by the Office of Business Economics. They are Wages and Salaries, Other Labor Income, Proprietors' Income, Property Income, Transfer Payments, and, a negative component, Personal Contributions for Social Insurance. Two principal advantages are gained in the study by using personal incomes as a dependent variable. The first is the availability of data. The second is seen by a brief examination of the weaknesses inherent in output models. Here some "residential industry" would result from demand originating in response to the inflow of transfer payments. While transfer payments are not an element of the "export base," the response to them in the residential sector is essentially the same as its response to income earned from the export of goods and services. The output models would be accurate, then, only to the extent that such considerations were allowed for.

^{4/} Ibid., Friedman and Alsonso, p. 246.

The Sources of Exogenous and Endogenous Income

With exogenous and endogenous income defined, the next problem is to identify the sources of regional income in these terms. A number of methods have been put forward in the literature. The most widely applied is the location quotient. Walter Isard defines it as a device for comparing a region's percentage share of a particular activity with its percentage share of some basic aggregate.^{5/} For example, the income location quotient for an industrial sector is:

$$L = \frac{\frac{y_A}{y_{US}}}{\frac{Y_A}{Y_{US}}} \quad (19)$$

where y is income received in the particular sector of the economy; Y is income received in all sectors of the economy; A is the particular region and US is all regions. For example, it would measure the portion of national manufacturing income received in the area related to the portion of total national income received in the area.

The choice of which type of location quotient should be used depends on what is to be measured in any given study. For example, income or employment location quotient would be appropriate in assessing the degree to which an industry exports goods and services. Values of L greater than unity generally indicate that at least some of the products of these industries are exported. Unity is not sacred; for example, Bolton used an L value of 1.2.

Limitations exist in the use of location quotients. One of the serious drawbacks is that their reliability depends on the level of aggregation applied. For example, within a two-digit Standard Industrial Classification which reflects no export orientation may exist one or more export-orientated three or four digit industries.

Another difficulty arises when the region under consideration is more productive than other regions included in the benchmark economy with which it is being compared. Tiebout suggests that this problem can be handled by

^{5/} Isard, Walter, et al., Methods of Regional Analysis: An Introduction to Regional Science. Technology Press and John Wiley & Sons, New York, 1960, p. 124.

adjusting an employment location coefficient to account for value added per employee.^{6/} Unfortunately the data to make such an adjustment are unavailable for this study.

Still another qualification is necessary to account for different expenditure patterns between two regions during the benchmark period even though income is the same in the two areas. Isard cites the example of different fuel consumption patterns among households in the North and South.^{7/} In this case, a fuel industry location coefficient less than unity would be consistent with fuel exports in the South, and in the North it could be greater than unity without being inconsistent with fuel imports. In addition to varying consumption patterns among regions with the same income, there is the additional problem of consumption patterns in the case where there is considerable difference in the level of income received by households.

In a recent study Leontief identified industries by ranking sectors according to their extent of inter-regional as opposed to intra-regional trade.^{8/} Industries primarily engaged in intra-regional trade were designated local and the remainder national. While the assumption of regional homogeneity is operationally valid for large regions, in small regions the identification of national and local industries on the basis of national trading patterns becomes more crucial and involves considerable risk.

Finally one may employ a a priori identification of sectors. The error in this approach depends, at least in part, on the wisdom of the investigator in making the decisions.

One problem, of course, is that some types of income come from industries clearly serving both regional and non-regional markets, for example manufacturing and agriculture. Severe data limitations covering such information have necessitated rather broad and, in some cases, somewhat arbitrary decisions on what to include in exogenous income in the model used in this study.

Transfer Payments and Federal Wages and Salaries are clearly exogenous and presented no classification problem. However, the present income model required a further disaggregation of government wages and salaries than is published in the six-state county income study. To compensate for this, one

6/ Tiebout, Charles M., The Community Economic Base Study. Committee for Economic Development, New York, 1962, p. 48.

7/ Isard, op. cit., pp. 125-126.

8/ Leontief, Wassily, et al., "The Economic Impact - Industrial and Regional - of an Arms Cut," The Review of Economics and Statistics, August 1965.

assumption had to be made. In order to show what portion of government wages and salaries was paid by federal and by state and local governments, the study had to assume that these governments contributed to exogenous and endogenous personal income (to wages and salaries) in the same proportion as they contributed to the personal income aggregate.

The limited detail of the data on Manufacturing Wages and Salaries prevented any classification indicating whether specific industries were exogenous or endogenous. It was decided, therefore, to include all Manufacturing Wages and Salaries in exogenous income. The same difficulties required placing all Property Income, Farm Proprietors' Income, Farm Wages and Salaries, Mining Wages and Salaries, and Other Wages and Salaries in the exogenous category. Undoubtedly, these classifications overstate the amount of exogenous income in the farm and manufacturing sectors. Clearly such manufacturing industries as printing and publishing, bakeries, and brick manufacturing are primarily residentiary, yet since the specific regional data are unavailable for any of these industries, it was not possible to estimate their contribution to endogenous income. For similar reasons, there exists some unclassifiable agricultural activity which is of a residentiary nature.

On the other hand, some income in the Finance and Transportation and in the State and Local Wages and Salaries sectors is exogenous in terms of a particular Standard Metropolitan Statistical Area (SMSA). It would be difficult to say on balance whether exogenous income is over-stated or under-stated by these groupings. While, hopefully, the net error is small, a definitive estimate is impossible.

Units of Observation

This study considers nine SMSA's located in five mid-western states.^{9/} Of these nine areas, two (Fayetteville and Little Rock) are located in Arkansas; two (Cedar Rapids and Des Moines) are located in Iowa; two (Wichita and Topeka) are located in Kansas; two (Tulsa and Oklahoma City) are located in Oklahoma; and one (Omaha) is located in Nebraska.

The county definitions applied to these SMSA's are as follows: Fayetteville consists of Washington County; Little Rock of Pulaski County; Cedar Rapids of Linn County; Des Moines of Polk County; Topeka of Shawnee County; Wichita of Sedgwick County; Tulsa includes Creek County, Tulsa County and Osage

^{9/} Two additional SMSA's were originally included but were later dropped. These are discussed in the Appendix.

County; Oklahoma City includes Canadian County, Cleveland County and Oklahoma County; and Omaha includes Douglas County and Sarpy County in Nebraska plus Pottawattamie County in Iowa. Omaha is the only SMSA used in this study that includes counties in two states.

The above definitions of SMSA's used in this study do not conform exactly to the current official definitions. However, an examination of historical data and of previous definitions of these SMSA's justifies the county definitions used in this study. They offer consistent data for the time period covered.

The use of SMSA's rather than counties per se helps to minimize the need for any adjustment of the data for the inter-county commuting of workers. It should be noted that the county income data used in the present study were not adjusted for commuting. As a result, economic areas broader than individual counties were required. SMSA units were an obvious choice.

Several SMSA's located in the six-state area had to be excluded from the study. Tex-Arkana and Davenport-Rock Island included counties outside the geographical area for which data are available in the six-state county income study. Further, SMSA's lying wholly or in part in Missouri are excluded because Missouri data are not consistent with the needs of the study.

The SMSA's included in this study, however, accounted for most of their states' prime military contract awards made during the applicable fiscal years. Of those awarded during 1960 and 1962, Wichita and Topeka accounted for 83 percent of the Kansas total; Fayetteville and Little Rock accounted for 30 percent of the Arkansas total; Tulsa and Oklahoma City accounted for 50 percent of the Oklahoma total; Omaha accounted for 75 percent of the Nebraska total; and Cedar Rapids and Des Moines accounted for 69 percent of the Iowa total. Overall, the nine SMSA's accounted for 71 percent of the prime contracts awarded in the five-state area.

Time Period

The regional growth model developed in this study is based on personal income data covering the period from 1950 through 1962. However, for the defense purchase portion of this study, the time period covered was from 1960 to 1962. This shorter time period was made necessary because earlier data for the prime military contract awards at the county level are not available. The short time period for which these data are available constitutes one of the limitations to this study; the importance of this limitation is discussed in a subsequent section.

Modification of the Model

The basic form of the impact model was developed in the previous chapter. Specifically the model is:

$$Y_d = \frac{1}{1-t} (s + X) \quad (17)$$

and

$$E = \frac{1}{1-t} (s + tX) . \quad (18)$$

It will be recalled that s and t are obtained from equation (15) in which $E = s + tY_d$. In equation (17) the $\frac{1}{1-t}$ term is a multiplier and s is the amount of spending that is independent of area income. An alternative expression of these relationships is:

$$Y_d = \frac{s}{1-t} + \frac{1}{1-t} X \quad (20)$$

and

$$E = \frac{s}{1-t} + \frac{t}{1-t} X . \quad (21)$$

Equations (20) and (21) can be re-expressed as follows:

$$Y_d = a_0 + a_1 X , \text{ and} \quad (22)$$

$$E = a_2 \text{ and } a_3 X . \quad (23)$$

Equation (22) states that total income (Y_d) consists of a constant amount (a_0) plus some multiple (a_1) of exogenous income (X). The next equation relates a multiple (a_3) of exogenous income (X) and a constant (a_2) to endogenous income (E).

From equations (22) and (23) it algebraically follows that, if a_1 or a_3 is known, then t can be computed, and then if a_0 or a_2 is known, s can be computed. The values of a_0 , a_1 , a_2 and a_3 can be derived by the least-squares regression fits of equations (22) and (23). Fitting equation (23) is superior to fitting equation (22); this is because the use of (23) avoids the statistical problem of multicollinearity.

Four forms of equation (23) were fitted by this method to obtain the equation which best meets the statistical test of a valid regression analysis. These general forms are:

- A. Absolute levels of E and X
 - 1. Levels of E and X
 - 2. Per capita levels of E and X
- B. First differences of E and X
 - 1. First differences of absolute levels of E and X
 - 2. First differences of per capita levels of E and X.

For these four equations, a mathematical relationship exists between the coefficients developed by the regression analysis. This allows the computation of four estimates for s and t and allows a choice to be made between them. This choice is made on statistical grounds.

From the above four fits of equation (23), the estimated values of s and t as calculated through per capita data were chosen for most of the subsequent analysis. In the tabular presentations, estimates are included to allow the reader to observe the consequence of the choice.

Estimates of s and t

Table 1 shows values of s and t that were obtained by the least-squares method of regression from fitting equation (23) in terms of absolute levels and in terms of per capita levels.

The sign and value of s is important. For an SMSA where s is positive (if r_{Y_d} is also positive) both Y_d and E grow more slowly than X . If the value of s is negative (if r_{Y_d} is again also positive) Y_d and E will have grown faster than X .

TABLE 1

ESTIMATES OF s AND t

<u>SMSA</u>	<u>Estimate of s</u>		<u>Estimate of t</u>	
	<u>Levels</u>	<u>Per Capita</u>	<u>Levels</u>	<u>Per Capita</u>
Fayetteville	-2.40	-2.33	0.45	0.47
Little Rock	28.95	31.51	0.52	0.47
Cedar Rapids	8.76	9.35	0.41	0.37
Des Moines	46.11	48.39	0.51	0.49
Topeka	27.42	30.88	0.50	0.44
Wichita	35.67	38.67	0.40	0.36
Omaha	54.51	57.09	0.45	0.42
Oklahoma City	5.76	6.30	0.45	0.45
Tulsa	-27.10	-26.66	0.55	0.56

It should be noted the values of s for each SMSA computed by absolute levels and per capita levels are fairly consistent. Using the per capita data in the regression reduced serial correlation by making an adjustment for the trend of population growth. It is significant that the values of s were not drastically changed by this adjustment.

Equation (17), $Y_d = \frac{1}{1-t} (s + X)$, may be modified to account for the effect of a change in exogenous income (X) on personal income (Y_d). The result of the modification is:

$$Y_d + \Delta Y_d = \frac{1}{1-t} (s + X + \Delta X) . \quad (24)$$

Subtracting equation (17) from equation (24) yields

$$\Delta Y_d = \frac{1}{1-t} \Delta X . \quad (25)$$

This equation holds when the value of s and t are constant. The term $\frac{1}{1-t}$ is a simple multiplier which shows the relationship between changes in exogenous income and personal income and is defined as $\frac{\Delta Y_d}{\Delta X}$.

Table 1 gives the values of t computed for each SMSA by fitting equation (23) for absolute levels and per capita levels. A general

interpretation of these values is that the smaller the t value is the larger the multiplier ($\frac{1}{1-t}$) and the larger the ratio $\frac{\Delta Y_d}{\Delta X}$. The converse is also true. Using the level values of t for Topeka as an example, the t value of 0.50 shows that when X increases by \$1 personal income will increase by \$2, since $\frac{1}{1-.50} = 0.2$.

IV. DEFENSE SPENDING MODEL

It should be noted at the outset of this chapter that the data used to formulate the defense spending model do not include prime contracts awarded by the National Aeronautics and Space Administration. Sufficient county data are not available for these contracts.^{10/}

This exclusion, however, does not nullify the importance of the defense spending model developed in this chapter. This model is general enough in character to accept NASA prime contract awards data when they become available. Furthermore, any other variables that can be quantified may be readily fit into this defense spending model and their impact can be measured.

There are three components of defense spending. These are the results of payments made for (1) defense procurement, (2) military wages and salaries, and (3) Department of Defense civilian wages and salaries. This chapter deals with the impact of defense spending for 1960 and 1962 on each of the SMSA's included in the study.

This chapter describes the methodology used to compute the figures for defense procurement. This description consists of several data "adjustments" necessary to formulate the defense procurement component into a form consistent with the other two components. The chapter also discusses the two other components of defense spending, military wages and salaries, and Department of Defense civilian wages and salaries.

Briefly the several "adjustments" of the procurement component are: (1) the county prime contract data for fiscal years are adjusted to Department of Defense prime contract award data for fiscal years; (2) the undistributed prime military contracts are allocated to the states and the SMSA's; (3) the estimate of the fiscal 1958, 1959, 1961, and 1963 prime military contracts for the SMSA's are made; (4) fiscal year data for the SMSA's are adjusted to calendar year data; (5) calendar year data for the SMSA's are modified for a time lag; (6) a "contract share" adjustment is made; and (7) the final figure for the defense procurement of each SMSA is adjusted to a personal income equivalent.

^{10/} Recent efforts have been made to generate additional data relating to NASA contracts and subcontracts, but the historical period covered by their data is not sufficient to allow their use in this study.

Basic Data for SMSA's

The fiscal 1960 data are obtained from Walter Isard and James Ganschow, Awards of Prime Military Contracts by State, County and Metropolitan Area of the United States, Fiscal 1960 (Regional Science Research Institute, Philadelphia, Pennsylvania), (referred to as FY1960). This report covers prime military contracts of \$10,000 or more awarded during the fiscal 1960. The total prime military contract awards, by county, within each state are broken down by four digit Standard Industrial Classification (SIC). The total prime military contract award data are new contracts less cancellations.

The data collected for fiscal 1962 are obtained from Walter Isard and Gerald J. Karaska, Unclassified Defense Contracts: Awards by County, State and Metropolitan Area of the United States, Fiscal Year 1962 (World Friends Research Center, Inc., Philadelphia, Pennsylvania), (referred to as FY1962). This report covers all unclassified prime military contracts of \$25,000 or more awarded during fiscal 1962. The total unclassified prime military contract awards, by county, within each state are again broken down by four digit Standard Industrial Classification (SIC).

The difference in the coverage between FY1960 and FY1962 is primarily that the latter data include only unclassified prime military contract awards. Awards which are classified for reasons of military security are not included.

The FY1962 data were developed primarily from issues of the Commerce Business Daily published by the U. S. Department of Commerce. This daily reports a major proportion of all unclassified defense contract awards. FY1962 records approximately 40 percent of the fiscal 1962 total dollar amount of prime military contracts as awarded and reported by the Department of Defense. This 40 percent is an overall average for all industrial categories. Major deviations exist among the specific industrial categories. These deviations became less important when various categories were grouped for the present study.

Consolidation of SIC

The FY1960 and FY1962 SIC categories were regrouped into four categories for each of the nine SMSA's. These consolidated categories are:

(1) SIC 15 - Contract Construction, (2) SIC 36 - Electrical Equipment, (3) SIC 37 - Aircraft, and (4) all other SIC categories. The consolidated SIC 37 category is considered primarily aircraft since SIC titles 3711, 3712, 3713, 3714, 3715 and 3716, all dealing with vehicle transportation, are insignificant in the SMSA's included in this study.

Adjustment of Isard Data to DOD Data

The FY1960 and FY1962 data are adjusted to take into account the difference between them and the Department of Defense (DOD) data for prime military contract awards. This adjustment allows the use of DOD figures for state prime military contract awards for fiscal 1958, 1959, 1960, 1961, 1962 and 1963.

The adjustment ratios for fiscal 1960 are computed by dividing the DOD state total of prime military contracts for the period by the state total of prime military contracts as shown in FY1960. The adjustment ratios for fiscal 1960 were as follows: Arkansas (0.81), Iowa (1.05), Kansas (0.93) Nebraska (1.06), and Oklahoma (0.98). Ratios of less than one reduce the FY1960 data, and ratios greater than one increase them.

Since the FY1962 data contained only unclassified military contracts, these data were adjusted to conform to both the FY1960 data which included all prime military contracts and to the DOD prime military contract data. Both of these adjustments can be made in one step. The adjustment divides the "state ratios" of total DOD prime military contracts for fiscal 1962 by the unclassified prime military contracts (FY1962) as shown in FY1962, Table 3, page 7. These state adjustment ratios are: Arkansas (13.98), Iowa (3.33), Kansas (5.91), Nebraska (0.40), and Oklahoma (1.49).

Some inconsistency may exist in either the FY1960 or FY1962 data for prime military contract awards to the SMSA's located in Arkansas. The 13.98 state adjustment ratio used for fiscal 1962 and, thus, used to adjust the SMSA's gives a seemingly disproportionate adjustment of the data for fiscal 1962 as compared to fiscal 1960. If this ratio is in error, then the error carries through the various adjustments made on the basic data and influences the final computations. Thus, the annual rates of growth of defense purchases for the Arkansas SMSA's should be expected to be somewhat high in comparison with those of the other SMSA's.

In making the above adjustment for fiscal 1960 and 1962, the Omaha data poses a problem. Since Omaha includes Douglas and Sarpy counties in Nebraska and Pottawattamie County in Iowa, a disaggregation of the Omaha SMSA

by state is required. Omaha's unclassified military contracts were first separated into Nebraska and Iowa sectors. These were individually adjusted by the applicable "state ratios" and, then, they were combined to get the SMSA total. For fiscal 1960, the disaggregation has little effect on the Omaha, total since the adjustment ratios for Nebraska and Iowa are 1.06 and 1.05 respectively. However, for fiscal 1962 this is not the case.

In the fiscal 1960 and 1962 data, Omaha had the largest portion of the nine SMSA's expenditures for contract construction; Cedar Rapids dominated the electrical equipment category; Wichita dominated the aircraft and "other" categories. In the fiscal 1962 data, Wichita and Tulsa combined, dominated the "other" category.

Allocation of Undistributed Prime Military Contracts

The data for state prime contract awards are taken from a DOD serial publication on prime contract awards.^{11/}

Two adjustments are made to these DOD data. The first adjustment is to determine the amount of prime contract awards which were not distributed by the DOD to the states in each of the fiscal years. The assumption made is that each state's share of the undistributed portion is equal to each state's share of the amount previously distributed in each fiscal year. The adjustment was made by multiplying each state's percent of the distributed awards by the total award amount not distributed to the states in each fiscal year.

The second adjustment made was to increase the prime military contract awards for each SMSA in fiscal 1960 and 1962 in order to reflect the increased state totals, resulting from the preceding adjustment for undistributed contract awards. (Pottawattamie County is included in the Nebraska adjusted total for fiscal 1960 and 1962, and it is excluded from the Iowa total for those years.) The percent share of the relevant state total (before the distribution adjustment) is computed for each SMSA for fiscal 1960 and 1962. This percent share of the state total is then used to correlate the SMSA's total prime military contracts with the adjusted state total prime military contracts.

Estimated Prime Military Contracts for Fiscal Years

Since data are not available showing prime military contracts for the SMSA's in fiscal 1958, 1959, 1961 and 1963, it was necessary to develop

^{11/} Office of the Secretary of Defense, Department of Defense Prime Contract Awards by State, monthly.

estimates for these years. The assumption is made that each SMSA shared in the state prime military contracts in these fiscal years on the same basis as it did in fiscal 1960 and 1962. This estimate was computed by dividing each SMSA's adjusted totals for fiscal 1960 and 1962 by the relevant state sum. From this, an average percent share for each SMSA was computed. This percent share for each SMSA was then multiplied by the state adjusted total for fiscal 1958, 1959, 1961 and 1963. This yielded an acceptable estimate of the prime military contracts awarded to each of the nine SMSA's.

(Note: At this point the data have been so adjusted that figures are available showing the prime military contract awards for both the states and the SMSA's for all fiscal years, 1958 through 1963.)

Fiscal Year to Calendar Year Adjustment

The next step was to adjust the fiscal year totals to calendar year totals. The Department of Defense series "Prime Contract Awards by State" presents a breakdown of prime military contracts by half years (January - June and July - December). On the basis of this breakdown, each SMSA's fiscal year totals were allocated to calendar years; i.e., fiscal 1959 is allocated by dividing the July through December, 1958, prime military contract figure for each state by the relevant state total prime military contracts for the entire 1959 fiscal year, to arrive at a percent of the 1959 fiscal year's prime military contracts that is to be placed in the 1958 calendar year. This percent allocation is then applied to each SMSA in the state for adjustment of the 1959 fiscal year data to calendar year data. The assumption, underlying in this method, is that the time phase of the awarding of prime military contracts in each SMSA follows the half-year time phase of its state.

Time Lag Adjustment

The next adjustment was required because there is a time lag in the actual spending of prime military contract awards. Following Bolton's analysis, the assumption was made that award expenditures are made over a three-year period. This assumes that 60 percent is spent in the year the contract is awarded; 30 percent is spent in the next year; 10 percent is spent in the third year. This relationship may be expressed as follows: let P = actual purchases in any particular year; let C = prime military contracts awarded in any year; and let t = the year under consideration. The formula for this lag adjustment is then:

$$P_t = 0.6C_t + 0.3C_{t-1} + 0.1C_{t-2}. \quad (26)$$

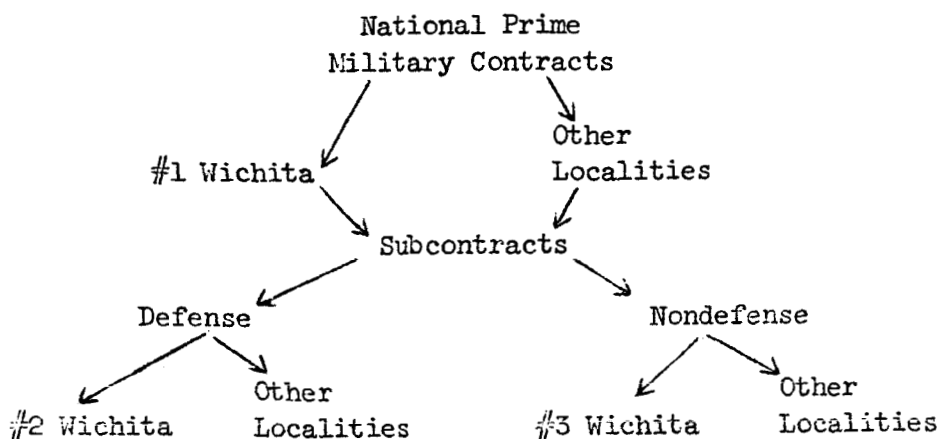
Ideally, each SMSA's time lag adjustment should be made for each of the four major categories of prime military contracts. Sources are available which indicate that the time lag for each category may vary. For instance, a recent study by Research Analysis Corporation, suggests that for the contract construction category 30 percent is spent in the first year; 60 percent in the second; and 10 percent in the third.^{12/}

However, to apply the relevant time lag to each of the four categories of contracts in each SMSA would require an allocation of prime military contracts by category by year. In making this allocation on the basis of each category's average percent of the total prime military contracts for fiscal 1960 and 1962, the model would do no more than lessen whatever fluctuations had occurred during the period. For this reason Bolton's time lag assumptions were applied to total prime military contracts.

Contract Share Adjustment

The contract share adjustment recognized that the total amounts of prime military contracts awarded in a SMSA do not necessarily remain in the area in the form of value added nor as purchases. Indeed, any value added resulting from prime military contracts awarded in any given SMSA are dispersed throughout the national economy.

The following diagram shows this dispersion.



^{12/} Research Analysis Corporation, Methodology of Industry Impact Analysis, Volume I: Methodology and Summary Results, March, 1966.

Of the total national prime military contracts awarded, part will be made to prime contractors in Wichita and the remainder to those in other localities. Of the total amount of prime military contracts awarded in Wichita and in other localities, only a part will remain in the locality as value added; the remainder will be subcontracted in different localities. Part of the total amount subcontracted will then be placed with defense related industries and part will be placed with nondefense related industries. From each of these categories (defense and nondefense) Wichita will gain a share as will all the other localities. To measure the total value added impact on Wichita, the impact at levels #1, #2, and #3 in the diagram must be totaled.

To compute this dispersion adjustment for each SMSA, the following formula was used:

$$V_A = \alpha C_A + \beta C_A + (1-\alpha-\beta) W_A. \quad (27)$$

where A = the SMSA and year,

V = the estimated share of total national prime military contracts adjusted for a time lag,

C = the SMSA's share of U. S. prime military contracts, and

W = the SMSA's share of U. S. manufacturing employment.

Basically this analysis follows the formulation used by Bolton. However, since data are not available to compute either the share of wages in "defense related" industries or the share of wages in "nondefense related" industries for each SMSA under consideration, different dispersion coefficients were used.

The values assigned for the weights α and β were: $\alpha = 0.5$ and $\beta = 0.2$. This follows directly from Bolton's analysis of the magnitude of each weight. In the above formula each weight -- α , β and $(1-\alpha-\beta)$ -- has a distinct meaning. Alpha (α) is the SMSA's average proportion of contract value added in the prime contractor's establishment. The value of β is the proportion produced outside the prime contractor's establishment but in defense related industries, either in the prime contractor's SMSA or outside it. The coefficient $(1-\alpha-\beta)$ is the proportion produced in nondefense related industries, within or outside of the prime contractor's SMSA.

Although a weight of $\alpha = 0.5$ was used it must be realized that this is a proportion which could vary according to the specific defense program and

the specific firms involved. There are some national data on the extent of subcontracting; these data show that between 40 and 60 percent of prime contract awards have been subcontracted. The portion varies over the years and depends on the structure of government purchases.^{13/}

Changing the value of α in the above equation does not necessarily lead to a change in the "V" values for each locality. Combined, the first two terms in the equation read:

$$V_A = (\alpha + \beta) C_A + (1-\alpha-\beta)W_A . \quad (28)$$

Since,

$$\alpha + \beta + (1-\alpha-\beta) = 1 ; \quad (29)$$

if changing the value of α only results in a change in the value of β , the value for V would remain constant. Only if a change in α were reflected in a change in $(1-\alpha-\beta)$ would there be any effect on V.

In three SMSA's for 1960 (Fayetteville, Little Rock and Des Moines) and two SMSA's for 1962 (Fayetteville and Des Moines), the computed value of $(1-\alpha-\beta)W_A$ was greater than $(\alpha + \beta)C_A$. In these SMSA's for both years, the time-lagged adjusted prime military contracts are small in relation to those of the other SMSA's. On this basis, the use of a $(1-\alpha-\beta)$ value of 0.3 to weight their "nondefense" portion seems to be the highest acceptable value.

Actually, the contract share arrived at through the above formula represents a maximum estimate for each SMSA. A more conservative estimate of the contract share would be the assumption that 50 percent of the prime military contract awards represent value added in the prime contractor's local establishment and that there is no feed-back to the SMSA through subcontracting via "defense" or "nondefense" related industries.

In order to make a more precise estimate of the contract share for each SMSA, a thorough examination of each firm that receives prime military contract awards would need to be undertaken. This examination would yield more knowledge of the values of the various weights for each firm in a given SMSA. However, this examination is beyond the limits of this study.

^{13/} Office of the Secretary of Defense, Military Prime Contract Awards and Subcontract Payments or Commitments, July 1964 - March 1965, n. d.

After the contract share figure is computed for each SMSA for 1960 and 1962, this percent is multiplied by the total national purchases for the relevant year. The resulting dollar figure is the defense procurement total for each SMSA in 1960 and 1962.

Defense Income Adjustment

The final adjustment made to derive a defense income figure was to translate defense procurement into personal income. The resulting estimates had to be consistent with the personal income figures used in the regional growth model and with the figures for federal military wages and salaries and DOD civilian wages and salaries. Three coefficients for this adjustment were tested, all of which are basic on national data. First, following Bolton's estimate, 70 percent of total procurement was included as the personal income equivalent. Second, the total United States personal income for 1960, 1961 and 1962 was totaled and divided by the United States total 1960, 1961 and 1962 GNP. The resulting ratio, 80 percent (0.7995), was used as the second estimate. Third, the mean of the two coefficients was used (0.75). The adjustment consists of multiplying the defense procurement total as computed above by the (0.75) In the subsequent presentation, the results of only the (0.75) adjustment are shown.

Defense Wages and Salaries

As defined at the beginning of this chapter, "defense spending" is composed of (1) defense procurement, (2) military wages and salaries, and (3) Department of Defense civilian wages and salaries. The development of defense procurement estimates for each locality has been dealt with. Now the estimates of the other two components are to be discussed.

Federal military wages and salaries and civilian wages and salaries for each SMSA were computed by using federal government wages and salaries data generated from the six-state county income study. Federal government wages and salaries consist of military wages and salaries and federally-paid civilian wages and salaries. Civilian wages and salaries can be further broken down into Department of Defense civilian wages and salaries and other civilian wages and salaries. For the years 1960, 1961 and 1962 data are available at both the national and state levels for all the components of federal government wages and salaries.

For each SMSA the allocation of federal government wages and salaries reflects both its state's ratio of federal military wages and salaries to federal government wages and salaries and its ratio of DOD civilian wages and

salaries to federal government wages and salaries. In each case, the wages and salaries are the combined totals for 1960 through 1962.

Presentation of Data

Table 2 shows the amount of prime military contracts awarded in each of the nine SMSA's for 1958 through 1962. These data include awards made in each year, but they do not contain the time-lag adjustment. Four of the SMSA's (Wichita, Topeka, Tulsa and Oklahoma City) show a definite decline in contract awards during the five year period, and three of the SMSA's (Omaha, Cedar Rapids and Des Moines) show a slight increase. The SMSA's in Arkansas show a sizable increase during the period.

Looking only at the prime military contract awards for 1960, 1961 and 1962 (the years of the most reliable data), much the same pattern develops. During this period awards to Wichita, Topeka, Tulsa, Omaha and Cedar Rapids decreased. Awards to Oklahoma City and Des Moines slightly increased. The awards to the SMSA's in Arkansas increased significantly.

TABLE 2

PRIME MILITARY CONTRACT AWARDS

Calendar Year

(\$1,000)

<u>SMSA</u>	<u>Time Period</u>				
	<u>1958</u>	<u>1959</u>	<u>1960</u>	<u>1961</u>	<u>1962</u>
Fayetteville	359	335	245	2,731	1,304
Little Rock	5,529	6,101	4,323	41,016	19,539
Cedar Rapids	94,734	107,889	101,573	115,505	99,094
Des Moines	2,207	2,210	1,794	3,113	2,775
Topeka	18,693	9,157	10,259	9,163	7,789
Wichita	913,506	423,437	460,403	471,110	422,170
Omaha	44,196	49,316	46,550	65,592	44,581
Oklahoma City	20,945	15,721	15,971	17,874	17,615
Tulsa	67,472	56,042	55,420	52,669	52,263

Table 3 shows the 1960 and 1962 data for prime military contracts that have been time-lagged to indicate the differences between the year of the contract award and the year of the spending impact. According to this adjustment, three SMSA's (Wichita, Topeka and Tulsa) experienced a decrease. Again, the only SMSA's realizing a significant increase are those in Arkansas.

TABLE 3
PRIME MILITARY CONTRACTS (LAGGED)

<u>SMSA</u>	Calendar Year	
	(\$1,000)	
	<u>Time Period</u>	
	<u>1960</u>	<u>1962</u>
Fayetteville	284	1,626
Little Rock	4,977	24,460
Cedar Rapids	102,784	104,265
Des Moines	1,960	2,778
Topeka	10,771	8,448
Wichita	494,624	440,675
Omaha	47,145	51,082
Oklahoma City	16,394	17,528
Tulsa	56,812	52,701

Tables 4 and 5 present total defense spending and its components for 1960 and 1962. For 1960, the absolute magnitude of Wichita's defense spending is almost twice that of the second ranked SMSA, Oklahoma City. Total defense spending in Fayetteville is quite small in comparison to the other SMSA's. For 1962, defense spending shows a similar pattern.

TABLE 4

DEFENSE SPENDING - 1960

(\$1,000)

<u>SMSA</u>	<u>Defense Procurement</u>	<u>Military Wages & Salaries</u>	<u>DOD Civilian W & S</u>	<u>Total Defense Spending</u>
Fayetteville	1,354	2,564	1,201	5,119
Little Rock	7,364	24,491	11,470	43,325
Cedar Rapids	63,073	2,110	1,671	66,854
Des Moines	8,276	8,448	6,690	23,414
Topeka	7,782	30,790	6,679	45,251
Wichita	285,870	31,381	6,808	324,059
Omaha	37,235	50,233	18,157	105,625
Oklahoma City	16,137	77,171	74,901	168,209
Tulsa	41,251	14,235	13,816	69,302

TABLE 5

DEFENSE SPENDING - 1962

(\$1,000)

<u>SMSA</u>	<u>Defense Procurement</u>	<u>Military Wages & Salaries</u>	<u>DOD Civilian W & S</u>	<u>Total Defense Spending</u>
Fayetteville	2,381	3,168	1,175	6,724
Little Rock	19,637	30,257	11,222	61,116
Cedar Rapids	67,587	2,046	1,886	71,519
Des Moines	10,287	8,191	7,547	26,025
Topeka	7,074	30,844	6,245	44,163
Wichita	268,812	31,436	6,365	306,613
Omaha	42,906	52,517	16,636	112,059
Oklahoma City	18,637	75,933	74,901	169,471
Tulsa	42,243	14,007	13,816	70,066

Table 6 shows the percent of exogenous income for each SMSA contributed by defense spending in 1960 and 1962. These percentages show the relative importance of defense spending to total exogenous income for each SMSA. For 1960, three SMSA's had a percentage of less than 15; three were in the 15 to 30 percent category; two were in the 30 to 50 percent category; and Wichita was over 50 percent. For 1962, again three localities had a percentage less than 15; four, one more than in 1960, were in the 15 to 30 percent category; Cedar Rapids was the only SMSA in the 30 to 50 percent category; and Wichita was again over 50 percent. Five of the SMSA's (Topeka, Wichita, Omaha, Tulsa and Oklahoma City) experienced a decrease in the defense spending share of exogenous income from 1960 to 1962. Fayetteville, Little Rock and Des Moines experienced increases, while in Cedar Rapids defense spending share remained about the same.

This shows that there is a wide range of differences in the relative importance of defense spending in the nine SMSA's. (Since there is a close correlation between exogenous income and total income, the same wide range of differences exists between defense spending and total personal income.) Further, since in several SMSA's defense spending became more important as a source of income growth and in other SMSA's defense spending became less important, the model should be capable of observing the contribution of changing levels of defense spending to regional income growth.

TABLE 6

DEFENSE SPENDING AS A PERCENT OF EXOGENOUS INCOME

<u>SMSA</u>	<u>Time Period</u>	
	<u>1960</u>	<u>1962</u>
Fayetteville	10.3	11.6
Little Rock	20.7	26.5
Cedar Rapids	34.3	34.5
Des Moines	6.9	7.2
Topeka	29.0	25.5
Wichita	66.7	58.2
Omaha	17.8	17.2
Oklahoma City	30.9	27.1
Tulsa	13.6	13.3

Defense Spending and Area Growth

An examination of the rates of growth of defense spending and of exogenous income provides an indication of the impact of defense spending on the growth of personal income. Table 7 shows the rates of growth of both defense spending and exogenous income for the 1960-1962 period. These growth rates were computed from the data measured in absolute levels and represent compound rates of growth.

Exogenous income for every SMSA grew at a positive rate during the period. This growth rate ranged from 5.5 percent for Fayetteville to 0.9 percent for Tulsa.

All but two SMSA's had positive growth rates in defense spending for the period. These two (Wichita and Topeka) had negative rates of growth in defense spending of 1.9 percent and 0.7 percent, respectively. The range of growth rates in defense spending shows a spread of from 12.2 percent for Little Rock to -1.9 percent for Wichita. The two SMSA's located in Arkansas had a growth rate above 9 percent, while the highest rate experienced by any other SMSA was Des Moines' 3.6 percent. As the results presented in Table 7 show there is no significant relationship between the rates of growth in defense spending and rates of growth in exogenous income. Since the correlation between exogenous income and total personal income is very high, the same lack of relationship exists between the rates of growth of defense spending and the rates of growth of total personal income.

TABLE 7

ANNUAL RATES OF GROWTH OF DEFENSE SPENDING AND EXOGENOUS INCOME

1960-1962

<u>SMSA</u>	<u>Annual Rates of Growth</u>	
	<u>Defense Spending</u>	<u>Exogenous Income</u>
Fayetteville	9.5	5.5
Little Rock	12.2	3.3
Cedar Rapids	2.3	2.0
Des Moines	3.6	2.0
Topeka	-0.7	3.4
Wichita	-1.9	2.7
Omaha	2.0	3.1
Oklahoma City	0.2	4.8
Tulsa	0.4	0.9

In order to assess the contribution of defense spending to area growth, more than the simple relation between the rates of growth of defense spending and exogenous income must be analyzed. Of equal importance to an analysis of the contribution of defense spending to area growth is the comparative roles played by defense spending and other components of exogenous income in the SMSA's total exogenous income.

The following formula presents a means of determining this comparison:

$$R_D = \frac{\frac{D}{x} r_D}{r_x} \quad (31)$$

In this formula the relative contribution of the growth of defense income to the growth of total income (R_D) for each SMSA is expressed in terms of the level of the SMSA's defense spending in 1960 (D), the level of exogenous income in 1960 (x), the rate of growth of defense income (r_D), and the rate of growth of exogenous income (r_x). This formula weights the growth rate in defense spending by its importance in the base year, and it expresses the result as a percent of the entire exogenous income growth rate. The results of these calculations are shown in Table 8.

TABLE 8

RELATIVE CONTRIBUTION OF DEFENSE SPENDING TO GROWTH

<u>SMSA</u>	<u>Relative Contribution of Defense Spending to Growth</u>
Fayetteville	17.86
Little Rock	76.56
Cedar Rapids	39.39
Des Moines	12.40
Topeka	-5.96
Wichita	-46.99
Omaha	11.46
Oklahoma City	1.29
Tulsa	6.03

The negative relative contribution for Wichita and Topeka indicates a depressing force on the growth of income in these two areas. Positive growth in exogenous income offsets this negative contribution so that total income rose in these SMSA's. The positive contributions were large in Little Rock and Cedar Rapids, and though smaller, they were still favorable in Fayetteville, Des Moines, Omaha, Tulsa and Oklahoma City.

What can be concluded is that little of the growth of exogenous income can be explained by the contribution of defense spending in Topeka, Oklahoma City and Tulsa. Some defense spending stimulation was present in Fayetteville, Des Moines and Omaha. Defense spending was a large stimulant to growth in Little Rock and Cedar Rapids, and a large depressant in Wichita.

V. CONCLUSION

Probably the most important conclusion that can be drawn from this analysis is that a local impact model can be developed. For some time, national economic models have been used to analyze the impact of economic events. Recently, models have been developed that perform this analysis for subnational or state areas. Some models have been applied to even smaller geographic areas. However, very little analysis of the economic impact of government procurement has been undertaken for a region smaller than a state. This study performed such an analysis.

The development of the impact model began with an elaborate macroeconomic formulation of the determination of an area's income. In this general model, recognition was given to the amount of foreign sales of goods produced in the area and the amount of purchases of goods produced outside the area. Although this model is theoretically adequate, data do not exist that would permit the statistical quantification of the various factors included in the theoretical determination of an area's income. Therefore, it was necessary to modify the formulation so as to maintain as much of the analytical rigor contained in the general model as possible and still structure the formulation in a manner that could be empirically tested. Such a modified model was developed in this study. In this model, area income was said to be determined by some multiple of the level of spending in the area that does not depend upon the level of the area's income. The multiplier is the typical Keynesian spending multiplier and is equal to one over one minus the marginal propensity to spend in the area from income earned in the area.

After the theoretical model was developed, the next step was to test this model through the use of the six-state county income data. In this testing, it was necessary to divide income into endogenous and exogenous components. If the units of observation were states, one could employ alternative definitions of exogenous income, that part of personal income which is subject to external forces, that part of personal income which is subject to internal forces. In this study, arbitrary decisions were made in order to categorize each component of personal income. The validity of this classification is attested to by the adequacy of the statistical results produced by the model.

From five midwestern states, eleven Standard Metropolitan Statistical Areas were chosen as the units in which the impact model was tested, the six-

state county income data provided the basic statistical information, and income was classified as exogenous or endogenous for the years 1950 through 1962.

It was found that very high levels of statistical confidence could be placed in the statistical estimates of the factors determining area income that were derived for nine of the eleven SMSA's. The peculiar situation in two of the SMSA's resulted in unsatisfactory statistical findings. For the remainder of the SMSA's, very consistent estimates were produced. For example, the estimate of the marginal propensity to spend for goods produced in the area only ranged between 0.40 and 0.52 for all nine areas. This high degree of consistency of the marginal propensity further supported the adequacy of the model and the county income data that were used in its testing.

Having developed an adequate impact model, it is possible to introduce a wide range of economic events into the model and to analyze the economic consequences of these events. In this study, the impact of changing levels of defense spending was chosen for analysis. This was not because of an overriding interest in Department of Defense activity but because reasonable data are available. Further, in many important respects, Department of Defense spending resembles the spending activity of NASA.

The data used to analyze the impact of defense spending are very scarce. In fact, much of the data used to estimate the three components of defense spending were constructed for this report. Military and civilian wages and salaries had to be estimated by pro-rating state military and civilian wages and salaries to the particular SMSA. For the largest portion of defense spending -- defense procurement -- very limited data are available. Contract award data for the SMSA's are only available for 1960 and 1962. In order to translate these contract award data into defense spending, a large number of adjustments and modifications were necessary. In adjusting these data, some serious doubts were raised regarding the validity of the 1962 data. Nonetheless, a series of defense procurement estimates were developed for 1960 and 1962. When defense procurement, military wages and salaries, and Department of Defense civilian wages and salaries were summed, an estimate of total defense spending for the nine SMSA's in 1960 and 1962 was produced. It may be concluded that even with limited data, it was possible to develop a reasonable measure of defense spending.

It was found that the portion of total personal income that was defense income varied widely among these nine SMSA's. It was very important in Wichita and, although less important, was significant in Cedar Rapids, Oklahoma City, and Topeka. On the other hand, defense spending was of little

importance in Des Moines and only slightly more important in Fayetteville and Tulsa. Between 1960 and 1962 there were substantial changes in defense spending. Little Rock and Fayetteville had a rapid growth in defense spending while Wichita and Topeka experienced significant declines.

It was found that it was possible to combine a consideration of the relative rate of growth of defense spending, the rate of growth of exogenous income, and the relative importance of defense spending in the area into one economic measure. By this measure, the relative contribution of defense spending to economic growth was quantified. It was found that the growth in defense spending accounted for a very large portion of the growth in Little Rock. In Cedar Rapids the contribution was also significant. Defense spending was found to be of somewhat less, but still positive, importance in Fayetteville, Des Moines, and Omaha. Finally, defense spending changes were a large negative contribution in Wichita; the growth of total income in Wichita was significantly depressed by the decline in defense spending. The other area that experienced a decline in the rate of defense spending between 1960 and 1962 was Topeka; here again the relative contribution of defense spending to growth was negative. Finally, it may be concluded that, even with these somewhat limited data, it has been possible to relate changing patterns of defense spending to area economic growth. When further data are available on NASA procurement activities, these data may be incorporated within this model and the contribution of NASA procurement activities analyzed.

APPENDIX

The results of fitting the impact model to the nine SMSA's' income data were presented in Table 1. In that table the only information that was provided was the value of the derived coefficients of the impact model -- the s and the t . As will be recalled these coefficients were obtained from the least-squares fitting of equation (23), $(E = a_2 + a_3X)$ where E is endogenous income and X is exogenous income.

Since the statistical tests of the "goodness of fit" is a technical matter, these tests were not discussed in the body of the report. However, since these tests are a measure of the impact model's adequacy, their presentation is important. Because of this, the usual statistical measures of the regression equations are presented in this Appendix.

Further, this Appendix discusses the two SMSA's for which the statistical analysis was performed, but for which the results were unsatisfactory, and explains the reasons for these unsatisfactory results.

Coefficient of Correlation

The coefficient of correlation for the regression equation measures that portion of variation of the equation's dependent variable which is accounted for by the variations in its independent variables. Table A-1 lists the nine SMSA's coefficients of correlation derived when the data are expressed in both absolute and per capita levels.

TABLE A-1

COEFFICIENTS OF CORRELATION OF REGRESSION EQUATION

<u>SMSA</u>	<u>Total</u>	<u>Per Capita</u>
Fayetteville	0.96	0.94
Little Rock	0.98	0.96
Cedar Rapids	0.97	0.83
Des Moines	0.99	0.99
Topeka	0.97	0.91
Wichita	0.96	0.88
Omaha	0.94	0.83
Oklahoma City	0.98	0.91
Tulsa	0.99	0.95

All of the 18 coefficients are significantly high; therefore, the statistical relationship may be judged to be measured quite accurately. Thus, at a minimum, 83 percent of the year-to-year variation in endogenous income is accounted for by the corresponding variation in exogenous income.

As is usual with this type of regression analysis, absolute levels of data produce higher and more consistent coefficients than those of the per capita data. However, the per capita results are very satisfactory, and since they avoid some of the statistical problems associated with the absolute level of formulation, they are used in the subsequent analysis.

The "t Test"

Because the calculated value of regression coefficients, a_2 and a_3 , is used to estimate the value of s and t , the estimates of s and t are only as satisfactory as the estimates of a_2 and a_3 . The statistical measure applied equally to both regressive coefficients in the "t test." Used to test the validity of the estimated coefficient, this test measures the degree of probability that calculated coefficient is a chance result.

In applying the "t test" account is taken of the number of observations (the number of yearly observations used) and the number of coefficients estimated (two). Since the most common level of confidence required is a five percent level, one must find that the estimated coefficient could be a chance result less than five times out of a hundred. For our number of observations and number of coefficients estimated the required "t value" is 2.16. This means that so long as the "t level" for the individual coefficient is greater than 2.16, we have a 95 percent level of confidence. The "t value" for a one percent level of confidence is 3.01; thus, a "t value" over 3.01 would yield a 99 confidence level.

Table A-2 lists the "t values" for the nine SMSA's. It shows that all but two of the coefficients are significant at the five percent level. For those two, a satisfactory level of confidence is obtained by using the alternative fit of the model. In addition to the two coefficients that are not quite significant at the five percent level, three coefficients are significant only at the five percent level. All the remaining 31 coefficients pass the test at a one percent level.

TABLE A-2

"t" VALUES FOR REGRESSION COEFFICIENTS

<u>SMSA</u>	<u>a₂ Coefficient</u>		<u>a₃ Coefficient</u>	
	<u>Absolute</u>	<u>Per Capita</u>	<u>Absolute</u>	<u>Per Capita</u>
Fayetteville	2.10	2.45	15.94	12.86
Little Rock	8.10	10.21	24.07	17.05
Cedar Rapids	2.45	2.51	18.14	7.21
Des Moines	13.58	14.03	40.22	29.16
Topeka	8.38	9.53	18.83	10.75
Wichita	3.24	4.15	15.46	8.81
Omaha	3.48	3.02	13.50	7.45
Oklahoma City	5.52	5.73	21.39	10.70
Tulsa	3.07	1.97	27.61	14.03

It will be resulted that the a_3 coefficient is used to calculate the value of t . (This t is the marginal propensity to spend within the area and should not be confused with the "t" test.) Since, the "t test" is so satisfactorily passed by the a_3 coefficient, the calculated value of t can be accepted with a high degree of confidence. As will be recalled, also, the value of a_2 and t are used to calculate the value of s . Fortunately, the coefficients that are estimated unsatisfactorily occur for only one data formulation of the two formulations shown for each SMSA. Thus, an estimate of s and t can be produced that carries a high level of confidence.

Omitted SMSA's

Throughout this report, nine SMSA's have been used as the units of observation. These nine do not represent all the SMSA's that were examined; rather, they are the SMSA's for which the results were satisfactory. Two additional SMSA's are not included in the body of the report. These two were Fort Smith, Arkansas (consisting of Sebastian County), and Pine Bluff, Arkansas (consisting of Jefferson County). This section of the Appendix outlines the results obtained for these areas and offers an explanation of these results.

The coefficients of correlation for Fort Smith were 0.0245 for absolute levels and 0.0034 for per capita levels; for Pine Bluff the coefficients were 0.3225 and 0.1362, respectively. None of these four correlation coefficients are satisfactory; almost none of the year-to-year variation of endogenous income is accounted for by the year-to-year variations of exogenous income. This alone would prohibit using these SMSA's in the subsequent analysis.

Furthermore, the "t test" results for these two SMSA's are unsatisfactory. A reasonable level of confidence could be placed in the estimate of a_2 but not in a_3 . But since the value of a_2 is useless without an estimate of t (obtained from the estimate of a_3) the results of the regression analysis cannot be used.

These totally unsatisfactory results may seem peculiar, particularly since the results for the other nine SMSA's were so satisfactory. In order to understand the cause of these results, the detailed six-state county income data were examined.

For Fort Smith the explanation of the results rests on the peculiarities of government wages and salaries. From 1957 to 1962, this component of personal income was subject to extreme variation. (In million dollars, the amount of government wages and salaries were: 1957 - 56.4; 1958 - 46.2; 1959 - 22.2; 1960 - 8.6; 1961 - 9.5; and 1962 - 49.4.) This variation resulted from the closing and opening of a federal installation in Fort Smith.

One would be tempted to argue that this extreme a variation cannot be measured by the model. To some extent this may be true, but almost as much variation was measurable in some of the other nine SMSA's. The full explanation of the Fort Smith situation is beyond the scope of this study. Probably the explanation involves (1) some inaccuracies in the county income data; (2) an inability of the model to handle so rapid and large a variation; and (3) the peculiarities of the Fort Smith SMSA.

In Pine Bluff the explanation is easier. Two years, 1952 and 1957, were completely out of line. An examination of these years shows an extreme variation in wages and salaries paid in the contract construction industry. (In million dollars, 1951 - 8.6; 1952 - 28.9; 1953 - 9.9; 1956 - 3.9; 1957 - 10.9; 1958 - 5.3.) The two years of large contract construction activity obviously resulted from external forces operating in the Pine Bluff economy.

This points out a limitation stemming from the way in which the impact model was tested -- a limitation of the test but not of the model itself. Because of the lack of adequate data, it was not possible to accurately separate construction activity into endogenous and exogenous income. Consequently, even though it is logical to assume that a part of such activity should be classified as exogenous, it was necessary to ignore the fact and consider all construction activity as endogenous income. Such a necessity distorts the data for the Pine Bluff SMSA.